ON SOME ALGAL STALACTITES OF THE YELLOWSTONE NATIONAL PARK.

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(WITH PLATE VIII)

DURING the summer of 1896, while making a collection of algæ living in the hot waters of Yellowstone Park, a curious phenomenon of algal growth was observed which, it is thought, is worthy of being recorded. It was the production by certain species of algæ of thalloid structures which, both from their appearance and their method of development, may be termed stalactites.

The most characteristic forms noticed occurred in a small cave made by the cone of a geyser. The entire inner surface of the roof was coated with the algæ, which formed shining black sheets or pendant masses of true stalactitic appearance (*fig. 1*). They looked not unlike a group of icicles depending from some ledge. Indeed, the arrangement of the grouping was quite similar, but as far as individual shape is concerned the algal thalli were much shorter, thicker, and more broadly conical than the common icicle form. Then, too, this typical shape showed variation in two directions. Many were mere knob-like processes, as large as one's fist, perhaps, while some formed masses of small, fleshy, toothed appendages. The plants chiefly concerned in the building up of these stalactites were *Schizothrix calcicola*, *Glœocapsa violacea*, and *Synechococcus aeruginosus*.

In order to explain the probable cause of this formation, it will first be necessary to call attention to a peculiar method of growth which characterizes species belonging to the group Oscillarieæ, and then to describe a little more fully the habitation of the algæ in question.

It is well known that when a bit of living Oscillatoria, Phor-

midium, or the like, is placed in a drop of water spread out on a surface, as on a mounting card, the filaments move away from each other so that they come to occupy the entire drop. In this moving about they arrange themselves in somewhat radial lines. This behavior on the part of these plants is frequently made use of in the preparation of dried mounts. A bell jar is placed over the card on which is the drop of water containing the algæ. This prevents evaporation for a few hours, which is as long as the filaments remain in action. When dried in this way the plant shows to very good advantage its texture and color.

The geyser in which the stalactites were found was situated on a knoll near the summit of a hill. Generally, the vent of a geyser occupies the center of the built-up cone. In this case the aperture was in the side of the cone, the center of which was entire and mound-shaped. This resulted in there being formed a cavity a foot or two in diameter and winding or irregular in shape. Since the opening was near the base of the cone, and small in comparison with the size of the cavity, only a limited amount of light could reach the interior. The geyser spurted hot water almost continuously, but in small quantities, which may have reached a height of a foot or two, had it not been intercepted by the dome of the deposit. As it was, the water struck the ceiling of the dome and most of it trickled back into the pit. A small stream of hot water issued from the vent with jets of steam.

The action of a geyser may undergo frequent change during its period of existence with regard either to the force exerted in projecting the water, or to the amount of water thrown off at an eruption, or to the length of the interval between eruptions. Consequently, it is reasonable to suppose that this particular geyser at some previous stage projected its stream of water to a less height than at present, that is, so that it did not come in contact with the dome. The steam, under such circumstances, would have condensed on the cold surface of the ceiling of the dome, forming drops of water which evidently would not have quickly evaporated, since they were kept in a moist atmosphere

and frequently reinforced by other condensations of steam. A place of abode of this kind, providing shade, protection, and constant moisture in small quantity, would favor the growth of such an alga as Schizothrix.

It is thought that the movement of the filaments produced in the drop of water on the mounting card is exactly what takes place in the drops of water suspended from the ceiling of the cave. These not being allowed to evaporate are soon so crowded with the rapidly growing filaments that the shape is permanently retained. Other drops are added, the alga grows into them, and a stalactite is built up. And thus, as it is not difficult to understand, the process of formation of mineral and algal stalactites is quite homologous.

In attempting to understand what must have been the past history of this algal colony, in order to account for the new form taken on by the thallus, one meets with a second problem of interest, that is, the adaptation of the algæ to their peculiar environment. Thus, (1) the algal structure is accustomed to a state of semi-darkness; even in bright sunlight the entrance of more than a small amount of diffused light into the cavity is prevented, and direct light is never possible. (2) It depends for its supply of moisture entirely upon that afforded by the eruption of the geyser. While the material that forms the cone of the geyser is of such nature that moisture can percolate through it, the fact that it is higher than the surrounding ground would leave it without opportunity for collecting moisture either in the form of rain or from underground springs. (3) It accommodates itself to the action of hot water, hot air, steam, and cold air. These forces operate at irregular but short intervals of time. (4) Accordingly, the growth is neither strictly aerophytic nor hydrophytic, but partakes of both characters.

The temperature of the hot air or steam in the upper part of the cavity was found to be 81° C., and this was probably the average temperature. Owing to the sudden bursts of steam and hot water, it was with much difficulty that a supply of the material could be secured. The greater part of this was dried

at once. Some which showed well the characteristic shape was preserved in a solution of formalin for study in the laboratory.

When first collected the algal growth showed the following features: The stratum was firm in substance; the entire surface of the sheet, teeth and stalactites was protected by a thin black membrane, fine in texture, smooth and shining; the inner parts were somewhat spongy, yet firm, and in color white, gray, or brownish, with violet, rose and blue-green tints in places. In making a cross section of a stalactite a laminated appearance was noticed (*fig. 2*). The lamellae were numerous and very thin. Some of the most perfectly formed stalactites, though not the largest, measured from 5–8^{cm} in length and 1.5–2^{cm} in diameter.

Upon returning to Minneapolis, a microscopic study of the formalin material showed that there were present a group of algae of which three members were constant. These were *Schizothrix calcicola*, *Glœocapsa violacea*, and *Synechococcus aeruginosus*, of which the following are descriptions based upon the Yellowstone material.

SCHIZOTHRIX CALCICOLA (Ag.) Gomont Monographie des Oscillariées, Ann. Sci. Nat. (Bot.) VII. **15**: 307. *pl. 8. fig. 1–3.* 1892. Tilden, Am. Alg. Cent. II, no. 180. 1896. (*Plate VIII, figs. 3, 4.*)

Stratum not encrusted with lime, somewhat gelatinous, very hard when dried, membranaceous, black or dark violet. Filaments strongly and sharply bent, interwoven; sheath firm, straight, in the beginning somewhat narrow, cylindrical, including one trichome, with age growing thicker, becoming somewhat lamellose, including two to many trichomes; trichomes pale aeruginous (after remaining in formalin several months), neither attenuate nor curved at the apex, not constricted at the dissepiments, 1.6μ in diameter; articulations in general 1–2 times longer than the diameter; apical cell rotund; dissepiments marked by protoplasmic granules.

It is the interwoven filaments of this plant alone which form the membrane of the stalactite. Empty sheaths are also present in great abundance throughout the whitish or light-colored interior.

It is necessary at this point to correct a mistake made in labeling the above species in *American Algae*, Century II. When the algae were first studied, before distributing them, although careful examination was made of various portions of the formalin material, it happened that no sheaths were found containing more than a single trichome. This made the plant appear very much like *Phormidium purpurascens*, as may be understood by referring to Gomont's description, and it was placed under this name. Later investigations have shown clearly that the Phormidium-like simple filaments are but young stages of *S. calcicola*.

SYNECHOCOCCUS AERUGINOSUS Naeg. Einz. Alg. 56. 1849.

Cells 3.2–8μ in diameter, spherical or oblong, aeruginous, with thin sheath, for the most part solitary but at times four or five joined in a pseudo-filament. (*Plate VIII, fig. 6.*)

With the lower power of the microscope these cells are readily seen, as they occur for the most part in heaps or masses and are bright blue-green in color. They are found only in the interior of the thallus.

GLŒOCAPSA VIOLACEA (Corda) Rabenh. Fl. Eur. Algar. **2**:41. 1865. (*Plate VIII, fig. 5.*) Forming the reddish or grayish violet portions of the interior of the thallus, mucilaginous; cells globose, 6.4–14.4μ in diameter; tegument not lamellose; cytoplasm aeruginous, granulate. These cells, for the most part empty and colorless, are very numerous throughout the interior portions of the structure.

Valley of the Nez Perces creek, Lower Geyser Basin, Yellowstone National Park. June 29, 1896.

Another species belonging to this group, *Phormidium laminosum*, is exceedingly abundant in the hot waters of the Park. In its normal condition it forms wide sheets, delicately granulose in substance, of no definite shape. It also formed hollow strings (suggesting a Tetraspora growth) rising from the bottom of hot springs and expanding at the surface into flat or bulbous masses. In a few instances it formed long narrow appendages supported by submerged grass stems (*figs. 7–8*). It is probable that

these were formed in a similar manner to the stalactites already described. The stems must have first been out of the water, however, to allow the steam to condense on them. Afterwards the weight of the stalactites would draw them into the water. One of these stalactites preserved in formalin shows a length of 45^{mm}, a maximum width at the base of 12^{mm}, and a minimum width at the tip of 6^{mm}. It is abruptly truncate at the tip, and is covered with a delicate green membrane, while the inner parts are lighter or whitish in color. In most cases these pendants formed a hollow tube closed at the tip.

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EXPLANATION OF PLATE VIII.

Fig. 1. View of stalactites *in situ*, natural size.

Fig. 2. Cross section of a stalactite showing lamellae and hollow central portion.

Fig. 3. Young filaments of *Schizothrix calcicola*.

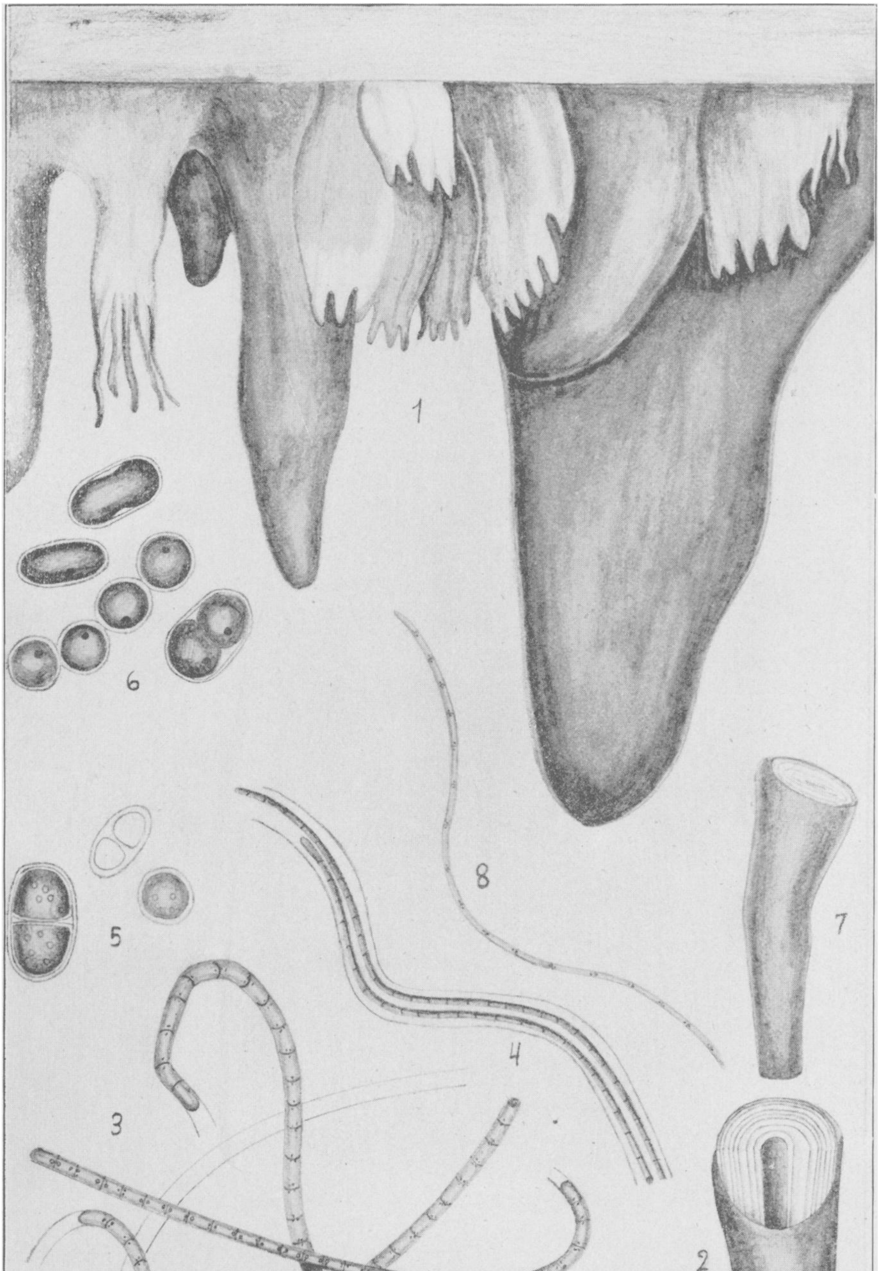
Fig. 4. Filament of same in later stage, with sheath containing two trichomes.

Fig. 5. Cells of *Glœocapsa violacea*.

Fig. 6. Cells of *Synechococcus aeruginosus*.

Fig. 7. Stalactite formed by *Phormidium laminosum*.

Fig. 8. Filament of *Phormidium laminosum*.



TILDEN on ALGAL STALACTITES.